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None

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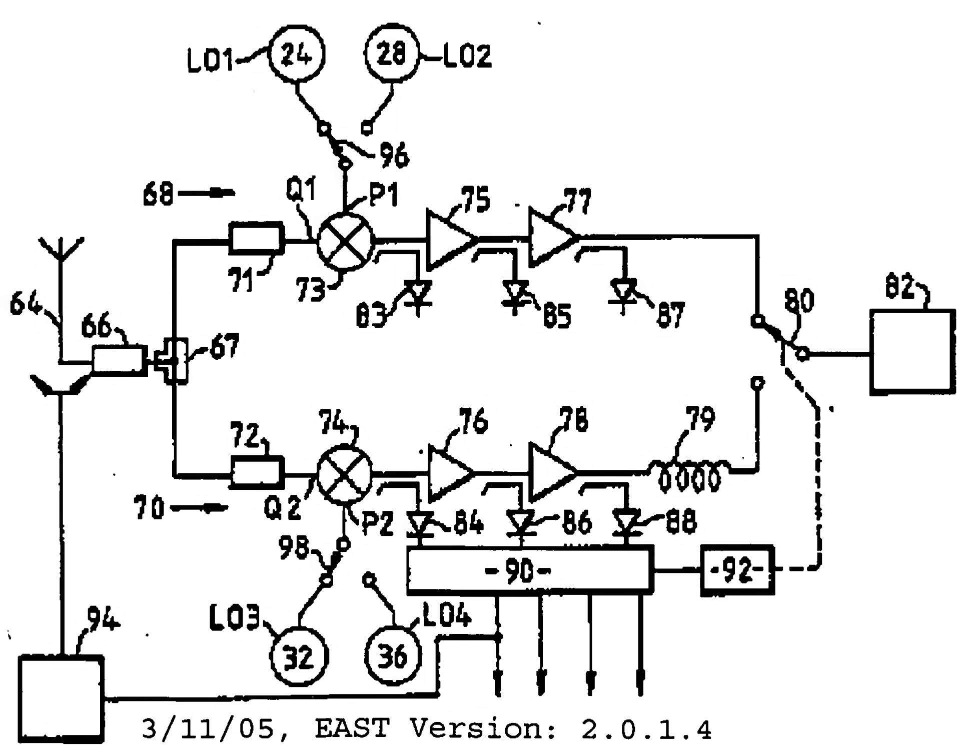
UK CL (Edition K) H3Q, H4L

(54) Electronic surveillance measuring receiver

(57) The receiver operating in the centimetric and millimetric ranges comprises first (68) and second (70) channels, each channel comprising a mixer (73 or 74), a pair of IF amplifiers (75, 77 or 76, 78), and log video detectors (83, 85, 87 or 84, 86, 88) for detecting a presence in the output of the mixer and/or amplifier(s) of the first or second channel. Pairs of local oscillators (LO1, LO3 or LO2, LO4) are connected alternately to the mixers (73, 74) of the first and second channels (68, 70), the frequencies of the pairs of local oscillators are selected such that the upper sideband of the lower local oscillator frequency overlaps the lower sideband of the upper local oscillator. Thus by monitoring the outputs of the video detectors it is possible to resolve presence in either the upper or lower sideband so that the frequency can be measured unambiguously on an IFM receiver (82) having a much narrower band than that covered by the receiver.

Fig.3B.



3/11/05, EAST Version: 2.0.1.4

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Fig.1(a).

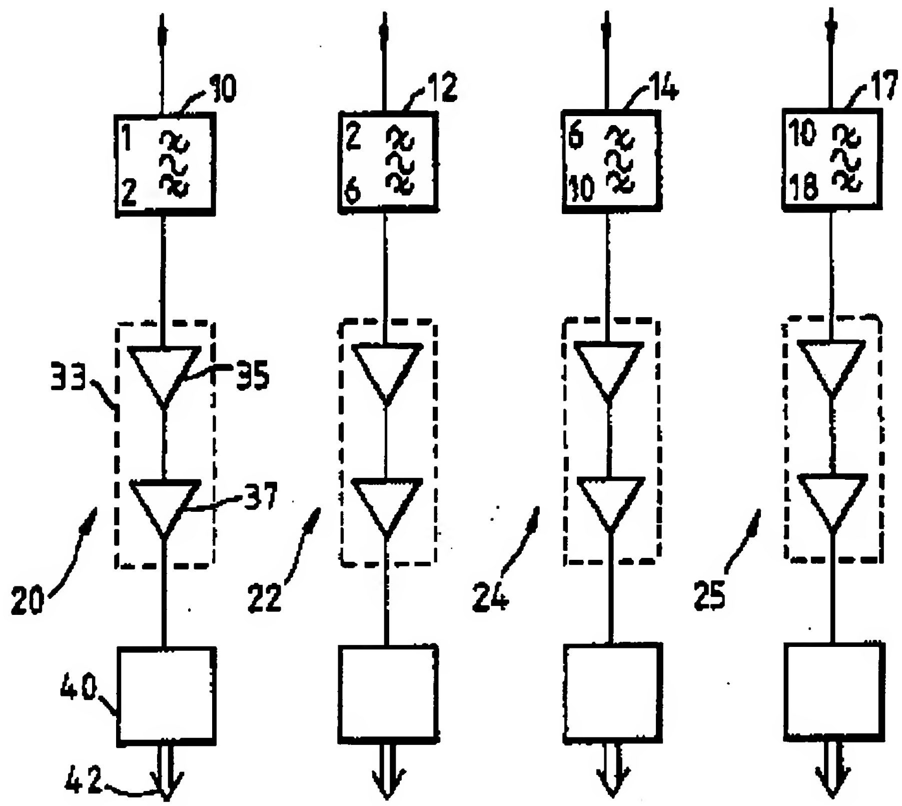

10
12
14
17
1
2
6
10
18
33
35
37
20
22
24
25
40
42

Fig.1(b).

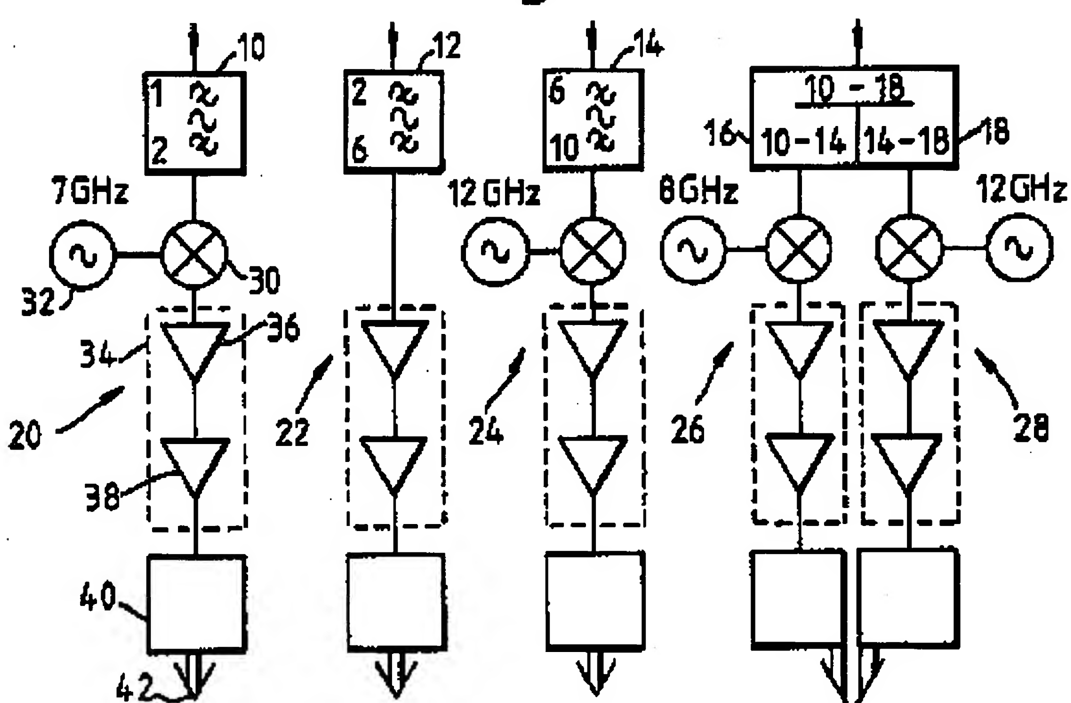

10
12
14
1
2
6
10
10 - 18
10-14
14-18
16
18
7GHz
12 GHz
8GHz
12GHz
30
32
34
36
38
20
22
24
26
28
40
42

Fig.2.

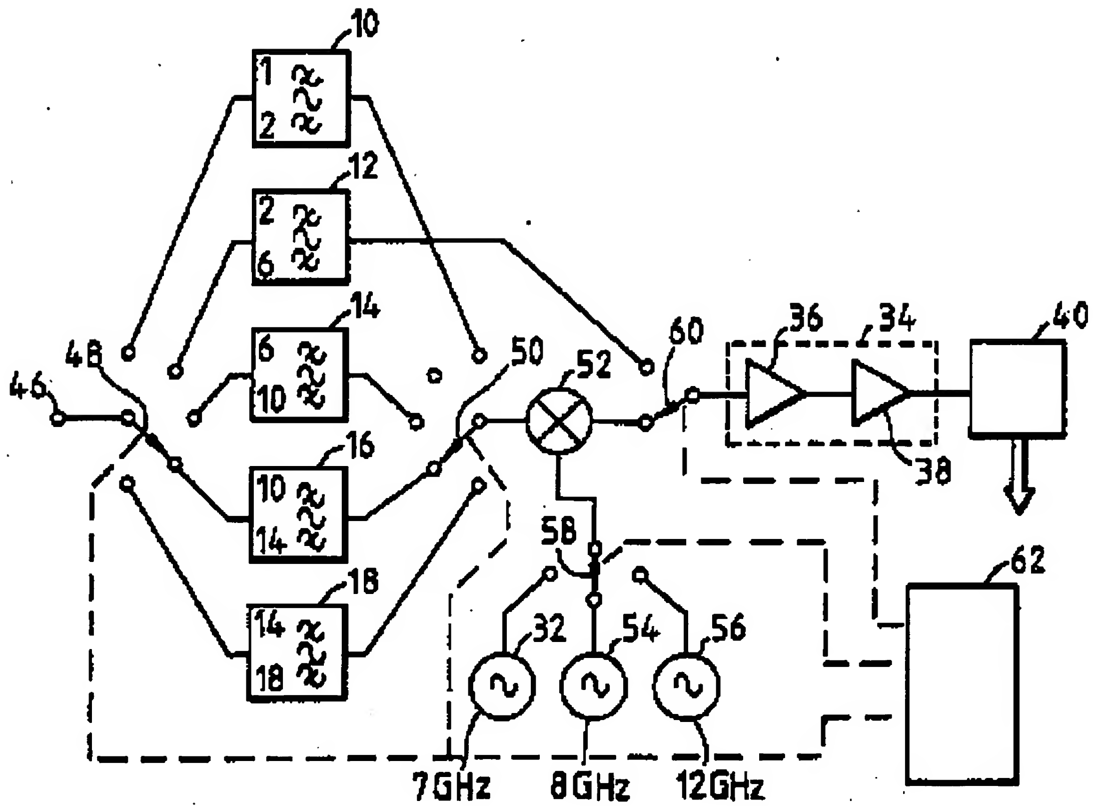

10
1
2
12
2
6
14
6
10
16
10
14
18
14
18
46
48
50
52
60
36
34
40
38
58
62
32
54
56
7GHz
8GHz
12GHz

Fig.3A.

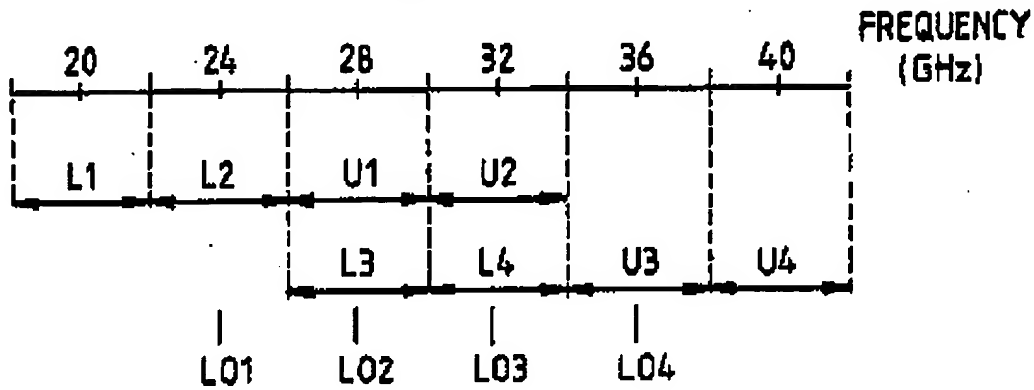

FREQUENCY (GHz)
20
24
28
32
36
40
L1
L2
U1
U2
L3
L4
U3
U4
LO1
LO2
LO3
LO4

Fig.3B.

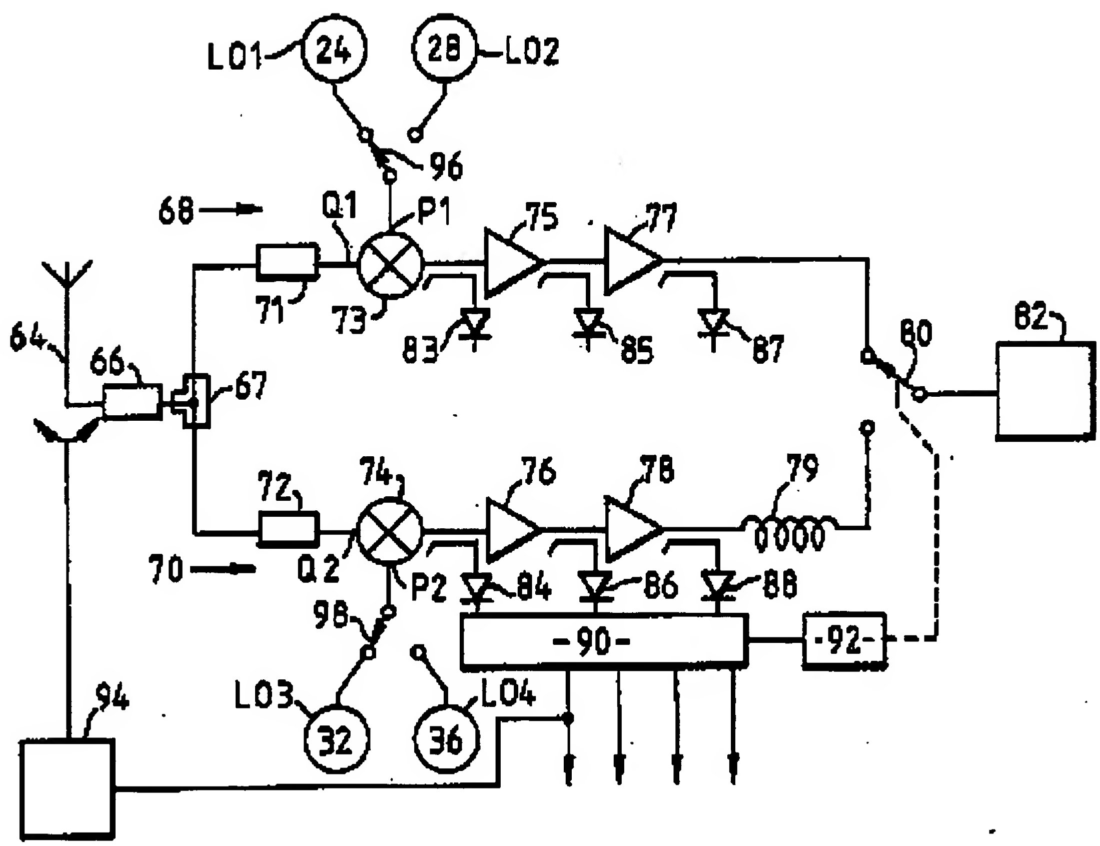

LO1
24
28
LO2
96
68
Q1
P1
75
77
71
73
83
85
87
80
82
64
66
67
72
74
76
78
79
70
Q2
P2
84
86
88
98
-90-
-92-
94
LO3
32
36
LO4

Fig.4.

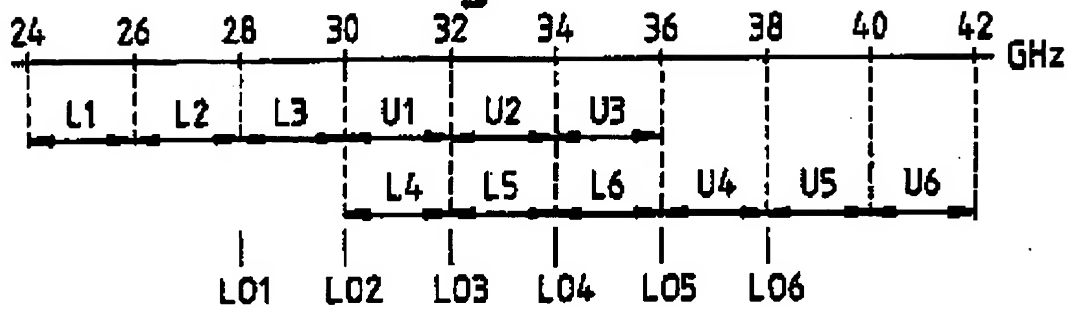


Fig.5A.

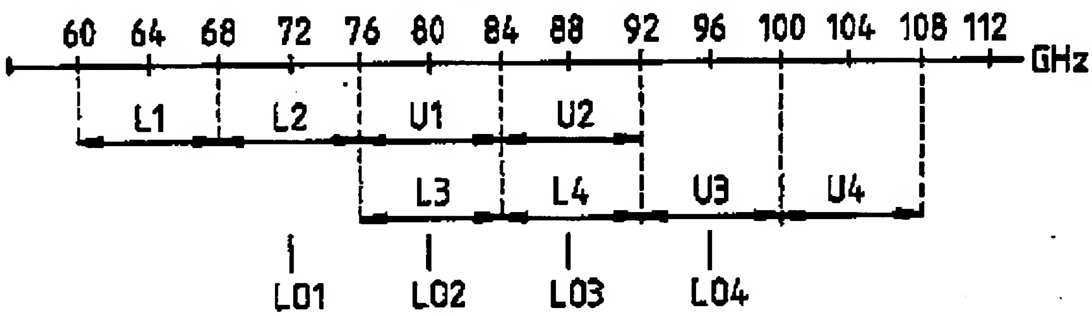
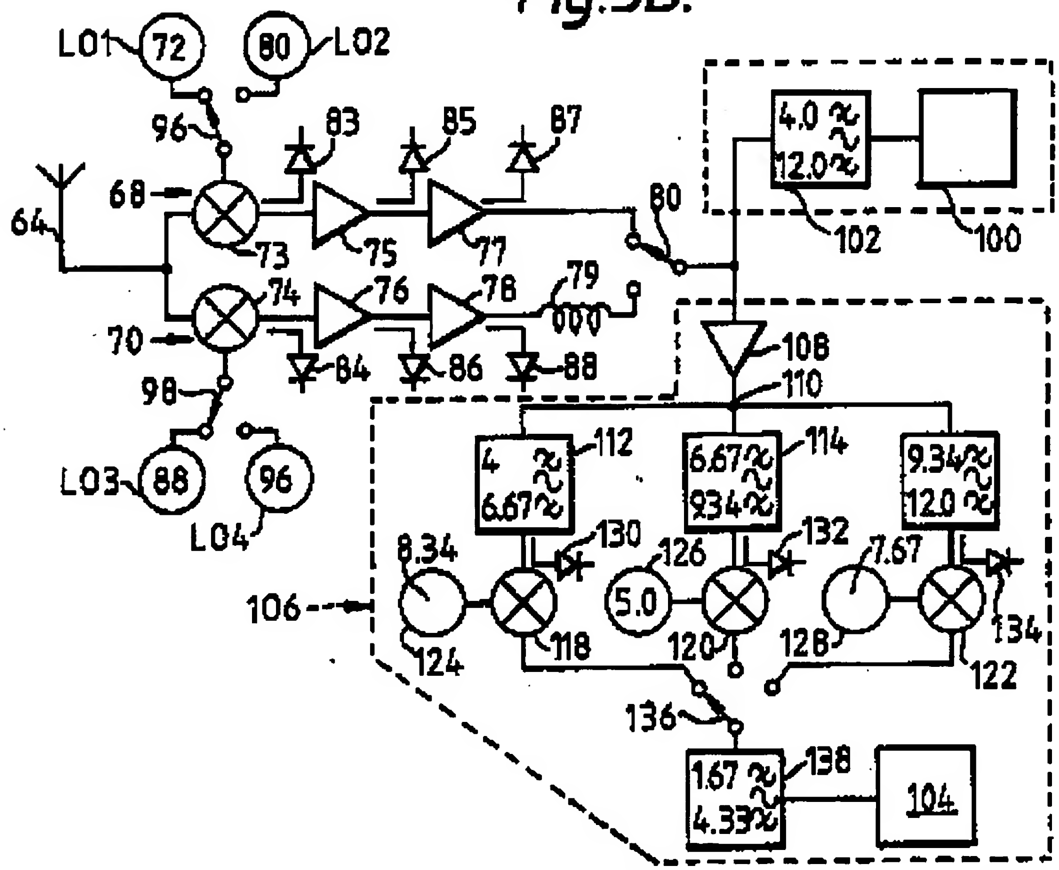


Fig.5B.



5.8.81

"ELECTRONIC SURVEILLANCE SYSTEMS"

The present invention relates to electronic surveillance systems, particularly, but not exclusively, to electronic surveillance measure (ESM) receivers monitoring pulsed radar emissions in the centimetric (3 to 30 GHz) and millimetric (30 to 300 GHz) wavelength ranges.

ESM receivers operating in the centimetric frequency range are well known. For convenience they can be classified into three schemes. The simplest arrangement conceptually splits the frequency band with a multiplexer and uses a baseband IFM (40) for each frequency range. The others have in common that a received pulsed radar emission is mixed down to the same intermediate frequency band. The difference between the schemes lies in the cost, complexity and in the probability of detecting a pulsed radar emission otherwise termed making an intercept. If 100% probability is desired then one must use a scheme such as is shown in Figures 1(a) or 1(b) of the accompanying drawings.

In Figures 1(a) and 1(b) the frequency range of interest is for example 1 to 18 GHz. In Figure 1(a) this frequency range is divided into a number of bands by means of bandpass filters 10, 12, 14 and 17 which respectively pass 1 to 2 GHz, 2 to 6 GHz, 6 to 10 GHz and 10 to 18 GHz. Each of the channels 20, 22, 24 and 25 associated with the filters 10, 12, 14 and 17 has an amplifier 33 formed by amplifying stages 35, 37, each providing typically 30 dB of gain. Each amplifier 33 is adapted to amplify signals in the pass band of its associate filter 10, 12, 14 and 17. The amplifier signal is then applied to an instantaneous frequency measuring (IFM) module 40 which provides an indication of the frequency of the received signal on its output 42. In the case of Figure 1(a) the IFM module is selected to be able to measure frequencies in its particular channel which means that no two

IFM modules 40 are the same. IFM modules are known in this art but for those unfamiliar with them it suffices to say that an IFM module measures the phase difference between two signal paths one of which comprises a calibrated length of coaxial cable which introduces a known phase shift into a signal which has been power split. A hybrid junction arrangement connected to the output of the coaxial cable and to the other signal path indicates the phase difference between the two signal paths and this is a direct measure of the frequency of the incident signal.

In Figure 1(b) the frequency range of 1 to 18 GHz is divided into a number of bands by means of bandpass filters 10, 12, 14, 16 and 18 which respectively pass 1 to 2 GHz, 2 to 6 GHz, 6 to 10 GHz, 10 to 14 GHz and 14 to 18 GHz. In the case of the filters 16 and 18 they are supplied from a common aerial via a diplexer. Each of the channels 20, 22, 24, 26 and 28 associated with the filters 10 to 18, respectively, has an IF frequency of 2 to 6 GHz which means in the case of the channels 20, 24, 26 and 28 that frequency band translation is necessary. This can be achieved by superheterodyning. As each of the channels 20, 24, 26 and 28 are the same only the channel 20 will be described. In the case of the channel 22 this only differs from the other channels because no frequency translation is required.

In the channel 20 the output of the bandpass filter 10 is mixed in a mixer 30 with a 7 GHz signal from a local oscillator 32. The output of the mixer 30 is amplified in an IF amplifier 34 formed by amplifying stages 36, 38, each providing typically 30 dB of gain. The amplified signal is then applied to an instantaneous frequency measuring (IFM) module 40 which provides an indication of the frequency of the received signal on its output 42. In this scheme the IFM module (40) measures the frequency of the IF signal and then adds-on or subtracts the local oscillator signal (if necessary) to obtain the actual frequency. Unlike the scheme shown in Figure 1(a), in Figure 1(b) the measuring range of the IFM modules is the same, namely 2 to 6 GHz. In order to translate the input signal in channels 24, 26 and 28 to this range,

their local oscillators respectively produce 12 GHz, 8 GHz and 12 GHz.

Whilst these schemes provide the probability of 100% intercept, good resolution and accuracy and good sensitivity, they have the disadvantage that they are expensive due to having several parallel channels and in the case of the scheme shown in Figure 1(a) a series of IFM modules have to be developed.

Another known ESM scheme is illustrated in Figure 2 of the accompanying drawings in which corresponding reference numerals have been used wherever appropriate to illustrate the same elements as in Figures 1(a) and 1(b). As in Figures 1(a) and 1(b), the scheme shown in block schematic form in Figure 2 is designed to make intercepts in the frequency range 1 to 18 GHz. The input signals are applied from say an antenna (not shown) to an input terminal 46. Instead of having 5 parallel channels as in Figure 1(b), there is a single frequency translation stage, to be described later, a single IF amplifier 34 and a single IFM module 40 capable of frequency measurement in the range 2 to 6 GHz, the bandpass filtered signal being multiplexed to the signal translation stage or to the IF amplifier 34 if no signal translation is necessary.

The signal at the input terminal 46 is applied via a switch 48 to each of the bandpass filters 10 to 18 in turn. Another switch 50 operated in synchronism with the switch 48 connects the filters 10, 14, 16 and 18 in turn to the signal translation stage which comprises a mixer 52 and local oscillators 32, 54, and 56 which respectively produce signals at 7, 8 and 12 GHz, the connection of any one of the local oscillators 32, 54 and 56 to the mixer 52 being enabled by a switch 58. The outputs of the mixer 52 and the bandpass filter 12 are connected to the IF amplifier via a switch 60. The switches 48, 50, 58 and 60 are controlled by a switch controller 62 which ensures that the appropriate bandpass filter 10 to 18 is connected between the input terminal 46 and the mixer 52 and/or the IF amplifier and that the correct local oscillator 32, 54 or 56 is connected to the

mixer 52.

Whilst the scheme shown in Figure 2 is more economical on components compared to the schemes shown in Figures 1(a) and 1(b), the multiplexing of the bandpass filters 10 to 18 means that the probability of an intercept is reduced because one is only looking at each filter for a fifth of the time. Furthermore, the dwell time in each band should be the typical radar pulse repetition interval (pri) for that band. Once an intercept has been made the switch controller 62 can lock the receiver to the particular filter and obtain more detailed information on pulse width, pri and any scan patterns (such as pri variation, frequency variation etc.). A further disadvantage of this system at millimetric wavelength ranges is that the multiplexer switches 48, 50 and 60 have to be constructed in waveguide which is difficult and expensive and introduces substantial losses in the signal path. The switch 48 can be omitted if each of the bandpass filters 10 to 18 has its own antenna.

It is an object of the present invention to provide an ESM receiver which has a high probability of intercept, is economical on components and can work at higher frequencies than the prior art receivers described above.

According to the present invention there is provided an electronic surveillance system in which a received signal is applied to at least two parallel channels, the channels including frequency translating means each of which includes means for producing different local oscillator (LO) signals which are so related that the upper sideband of the lower LO frequency produced in one channel overlaps the lower sideband of the upper LO frequency produced in the other channel, amplifying means in each channel for amplifying the output of the frequency translating means, means associated with each channel for detecting presence of a sideband signal in either or both channels, and means responsive to the detection of a signal for connecting an instantaneous frequency measuring device to the selected channel.

By means of the system in accordance with the present invention quite a wide frequency range is covered using fewer components than in the arrangement shown in Figures 1(a) and 1(b), but at the same time provides a high probability of detection and enables a single IFM module of limited bandwidth to cover a frequency range of greater bandwidth.

Single pulse presence detection with a probability of 50% is obtainable by first and second LO signal producing means being associated with each of the signal translating means and switching means being provided for simultaneously switching between the first and second LO signal producing means. The frequencies of the LO signal producing means are such that the sidebands which may be produced when the first LO signal producing means are selected interleave contiguously with the sidebands which may be produced when the second LO signal producing means are selected to cover the bandwidth of the frequency range being surveyed.

If desired the system may further comprise means for frequency analysing a signal in the selected channel, the frequency analysing means comprising a plurality of further channels, each having a bandpass filter, the pass bands of the filters being contiguous over the frequency range of the sideband of interest, further frequency translation means connected to the output of the bandpass filter and a detector for detecting the presence of a signal in its associated further channel, and switching means controllable in response to the detection of a presence in one of the further channels for connecting said one further channel to the instantaneous frequency measuring device.

The channels should be balanced as far as amplitude is concerned, that is their static gain characteristics should be as near as practically possible the same so that both give substantially the same output.

It is desirable to provide signal isolation between the mixers in each channel to reduce the risk of the local oscillator frequency of the complementary mixer appearing as an input

with a fixed frequency offset.

In order to avoid harmonic generation at high input power levels and possible ambiguities in frequency measurement, it may be desired to limit the input power of the fundamental. By limiting the input power the risk of damaging the mixers by high power input signals is also reduced.

The present invention will now be described, by way of example, with reference to Figures 3A to 5B of the accompanying drawings, wherein:

Figure 3A is a frequency distribution diagram associated with the operation of an embodiment of the invention having four local oscillators shown in Figure 3B,

Figure 4 is a frequency distribution diagram relating to a non-illustrated modification of the embodiment shown in Figure 3B having six local oscillators, and

Figure 5A is a frequency distribution diagram associated with the operation of another embodiment of the invention which can be implemented in one of two ways as shown in Figure 5B.

In the following description corresponding reference numerals have been used to illustrate the same elements.

Figures 3A and 3B illustrate an embodiment of the present invention which is adapted to detect pulsed radar signals generally in the K-band (20 to 40 GHz) although in fact it covers the range 18 to 42 GHz in two parts, 18 to 34 GHz and 26 to 42 GHz, as will be described.

The block schematic circuit shown in Figure 3B comprises an antenna 64 which is coupled by way of a signal limiter 66 and a hybrid power splitter 67 to two parallel arranged mixer/amplifier channels 68, 70. Each channel 68, 70 respectively comprises an isolating device 71, 72, a mixer 73, 74, and a two stage IF amplifier comprising 30 dB amplifiers 75, 77 and 76, 78. The static gain characteristics of the pairs of amplifiers 75, 77 and 76, 78 should be substantially the same. A delay device 79 comprising a coil of coaxial cable connects the output of the amplifier 78 to one fixed terminal of a two position switch 80

whose other fixed terminal is connected to the output of the amplifier 77. The output from the switch 80 is connected to an IFM module 82 capable of measuring frequencies in the range 2 to 6 GHz. Logarithmic (log) video detectors 83 to 88 are connected to the outputs of the mixers 73, 74 and the amplifiers 75 to 78 and serve the purposes of determining the presence of a signal in the channels 68 and/or 70 and the strength of the signal. The log video detectors 83 to 88 are connected to a signal processing module 90, which may comprise a microcomputer. For the sake of clarity only the log video detectors 84, 86 and 88 have been shown connected to the module 90. The outputs from the module 90 may include indications of the presence of a signal, its pulse width and amplitude, a video output and a signal to a logic module 92 which amongst other things controls the operation of the switch 80 between the channels 68 and 70. If the antenna 64 is a scanning antenna then an indication of its angular position can be provided by a shaft encoder 94 whose output, combined with the "presence" output from the module 90, can be used to provide a situation displace of the emitter environment.

Local oscillators LO1 (24 GHz) and LO2 (28 GHz) are connectable to an input port P1 of the mixer 73 <u>via</u> a switch 96. Similarly local oscillators LO3 (32 GHz) and LO4 (36 GHz) are connectable to an input port P2 of the mixer 74 <u>via</u> a switch 98. The switches 96, 98 are operated in synchronism so that either the local oscillators LO1 and LO3 are selected or the local oscillators LO2 and LO4. The choice of the local oscillator frequencies is made having regard to the measuring bandwidth of the IFM module 82 and the fact that the upper sideband (U) of one frequency translated signal overlaps the lower sideband (L) of the other frequency translated signal. This is shown in Figure 3A where sidebands U1 and L3 (26 to 30 GHz) and sidebands U2 and L4 (30 to 34 GHz) overlap.

Before describing the operation of the circuit illustrated in Figure 3B it is worth mentioning that the gains of the channels

68, 70 should be matched within approximately 3 dB and that the outputs of the mixers 73 and 74 are filtered so that those sidebands lying in the frequency range of measurement, that is 18 to 34 GHz and 26 to 42 GHz, are amplified whereas any other signals are either blocked or undergo little amplification.

In describing the operation of the circuit shown in Figure 3B, it will be assumed that the switches 96 and 98 are in the positions shown so that local oscillators LO1 and LO3 are connected to their respective mixers 73, 74. Consequently in the channel 68 the lower (L1) and upper (U1) sidebands of 18 to 22 and 26 to 30 GHz are monitored and in the channel 70 the lower (L3) and upper (U3) sidebands of 26 to 30 and 34 to 38 GHz are monitored. Accordingly if a radar pulse having a frequency of 20 GHz is received by the antenna 64 then as it lies in the sideband L1 it will be amplified by the amplifiers 75, 77. One or more of the log video detectors 83, 85 and 87 will detect the presence of a signal so that the switch 80 remains as set and the frequency of the translated 20 GHz input signal is measured by the IFM module 82. The 20 GHz signal will also undergo frequency translation in the mixer 74 but as the output therefrom does not lie within an acceptable band it will not be amplified and hence the presence of a signal will not be detected by the log video detectors 84, 86 and 88.

If the received radar pulse has a frequency of 36 GHz then the channel 70 will be operative and the presence of a signal will be detected by one or more of the log video detectors 84, 86 and 88. The signal processing module 90 notes that the signal has been detected in the channel 70 and instructs the logic module 92 to change-over the switch 80 to its lower position. In order not to lose the signal in the channel 70 the delay device 79 introduces a sufficient time delay that the switch 80 can operate. Thereafter the frequency is measured by the IFM module 82.

If the received radar pulse has a frequency of 28 GHz so that after frequency translation it lies in the upper sideband

(U1) from the mixer 73 and the lower sideband (L3) from the mixer 74, then the log video detectors in both channels indicate a presence. In order to avoid the switch 80 being forced to hunt between both channels, the signal processing module 90 is programmed so that the switch 80 remains switched to the channel 68. As before the frequency of the sideband is measured in the IFM module 82.

By a simple logic operation the illustrated system can determine if a signal is in sideband L1, sideband U3 or overlapping sidebands U1, L3.

The remainder of the 18 to 42 GHz band is covered by operating the switches 96 and 98 so that the local oscillators LO2 and LO4 are connected to their respective mixers 73, 74. In this condition the sidebands L2, U2, L4 and U4 are of interest and the operation is as exemplified above in the case of pulsed radar signals lying in the 22 to 26, 30 to 34 and 38 to 42 GHz bands.

If the switches 96 and 98 are clocked every 100 nanoseconds then there is a 50% probability of detecting the presence of signals having pulse widths of 100 nanoseconds or more. The probability is increased if the received signals comprise a burst of pulses, each pulse being of 100 nanoseconds or more. Once a presence has been detected in one of the channels 68, 70, then the signal processing module 90 can be arranged to hold the switches 80, 96 and 98 in the position in which the presence was detected. Detailed analysis of the emitter can then be performed to determine any characteristic modulation functions that will allow identification. The receiver described illustrates how a limited bandwidth IFM module 82 can be used to detect and measure the frequency of an emitter in a band six times that of the module 82. More important it shows how an IFM can be used to monitor simultaneously a frequency range three times its own bandwidth and requires only simple detectors and logic to resolve any possible ambiguities. Previously disclosed ESM receiver configurations can only simultaneously monitor a bandwidth equal

to that of the IFM. Thus across the present frequency range a single switched IFM arrangement (equivalent to Figure 2) could only give 17% probability of intercept on a single pulse emission whereas the proposed new configuration gives 50% probability of intercept using the same IFM.

The log video detectors 83 to 88 also serve an additional purpose to that of measuring the signal presence and this is to provide an indication of the amplitude of the signal from the mixers 73, 74. The amplitude information is useful in determining the nearness of the source of radar emissions and whether the source is approaching or receding. Dynamic range of signal amplification is enhanced by having three log video detectors 83, 85 and 87 and 84, 86 and 88 in each of the channels 68, 70 connected respectively to the output of the mixer 73 or 74, first amplifier 75 or 76 and second amplifier 77 or 78, and summing their outputs. Any signal whose amplitude does not exceed the threshold level of the third detector will not be measured because its presence will not have been detected. The IFM module 82 uses phase to measure frequency and in simultaneous signal situations it is preferable that the signal on its input is saturated. Accordingly the static gains of the channels are matched as near as is possible.

Other refinements in the circuit shown in Figure 3B include the signal limiter 66 which serves to protect the mixers 73, 74 from large amplitude signals, and reduces the possibility of harmonics of incident signals being falsely registered as true signals.

The power splitter 67 between the signal limiter 66 and the parallel channels 68, 70 may be implemented using a matched magic tee which gives 20 dB isolation between the channels. It is necessary to ensure adequate isolation between the mixers 73, 74 and the pairs of local oscillators LO3, LO4 and LO1, LO2 respectively, feeding the complementary mixers because the local oscillator frequency of the complementary mixer would appear as a signal with fixed 8 GHz offset. Ideally there should be a minimum of 60 to 75 dB of isolation between the local oscillator port P1 (or P2) and the

input Q2 (or Q1) to the complementary mixer. This can be achieved by the power split 67 providing 15 to 20 dB of isolation, and the isolating devices 71, 72 each providing 20 dB at the expense of an insertion loss of 1.5 dB. The RF to LO isolation of the mixers 73, 74 provide a further 25 dB of isolation. In order that the non-connected local oscillators LO2, LO4 do not mix with the connected local oscillators LO1, LO3 and present a false signal the isolation in switches 96, 98 should be of the order 60 to 70 dB.

In implementing the circuit shown in Figure 3B the mixers can be fabricated in ridge waveguide.

Figure 4 is a frequency distribution diagram illustrating how signals in the frequency range 24 to 42 GHz can be covered using an IFM module capable of measuring frequencies in the range 2 to 4 GHz. Looking at Figure 3B, the circuit would be basically the same with the exception that there would be three local oscillators LO1, LO2, and LO3 connectable in turn to the mixer 73 in the channel 68 and three more local oscillators LO4, LO5 and LO6 connectable in turn to the mixer 74 in the channel 70. Reverting to Figure 4, the local oscillators LO1 to LO6 are multiplexed so that the presence of a signal in this band (24 to 42 GHz) is initially checked by considering the sidebands L1, U1, L4 and U4, then L2, U2, L5 and U5 and finally L3, U3, L6 and U6. Once a presence has been detected in a sideband or sidebands then the signal processing module 90 can modify the multiplexing of the local oscillators to allow more detailed monitoring in the required frequency range. In the normal mode of operation the probability of intercepting a single pulse of pulsed radar signal is 33⅓%. This compares favourably with 17% obtained with a band switching arrangement.

The embodiments illustrated in Figures 5A and 5B concern monitoring for the presence of a signal in the frequency range 60 to 108 GHz which is effectively the M-band. Up to the output of the switch 80 the circuit components are essentially the same as in Figure 3B although certain components have been omitted from Figure 5B in the interests of simplicity of the drawing.

If an IFM module 100 capable of measuring frequencies in the range 4 to 12 GHz is available then the output of the switch 80 is connected to a bandpass filter 102 having a pass band of 4 to 12 GHz. The output of this filter 102 is connected to the IFM module-100.

If an IFM module 104 capable of measuring frequencies in the range 1.5 to 4.5 GHz is available then the arrangement shown in broken line box 106 can be used. The output of the switch 80 is connected to a field effect transistor (FET) amplifier 108 which is capable of amplifying signals in the range 4 to 12 GHz. Three bandpass filters 112, 114 and 116 are connected to a junction 110 at the output of the FET amplifier 108. The pass bands of the filters 112, 114 and 116 are respectively 4 to 6.67 GHz, 6.67 to 9.34 GHz and 9.34 to 12 GHz. The outputs of the filters 112, 114 and 116 are connected to respective mixers 118, 120 and 122 having associated local oscillators 124 (8.34 GHz), 126 (5.0 GHz) and 128 (7.67 GHz). The selection of the local oscillator frequencies is determined by the passband of the filters 112, 114 and 116 and the measuring range of the IFM module 104. Logarithmic video detectors 130, 132 and 134 are provided to sense the presence of a signal in one of the three signal paths from the bandpass filters 112, 114 and 116. When a signal is detected then a switch 136 is switched to that path to connect it to the IFM module 104 <u>via</u> a 1.67 to 4.33 GHz bandpass filter 138. If necessary delay devices (not shown) may be provided in the signal paths to the switch terminals so that the signal will not be lost by the operation of the switch 136.

The operation of the illustrated circuit is much the same as that described with reference to Figure 3B and accordingly it will not be repeated again in detail. The local oscillators LO1 to LO4 respectively have the frequencies 72, 80, 88 and 96 GHz which means that with the switches 96, 98 in their left hand positions that the sidebands L1 (60 to 68 GHz), U1, L3 (76 to 84 GHz) and U3 (92 to 100 GHz) are monitored, and in their right

hand positions that the sidebands L2 (68 to 76 GHz), U2, L4 (84 to 92 GHz) and U4 (100 to 108 GHz) are monitored. By having two local oscillators associated with each channel 68, 70 the probability of sensing a single radar pulse is 50%. As described before, if a presence is sensed by the log video detectors 83 to 88 then the switches 80, 96 and 98 can be operated to provide a 100% probability of sensing a subsequent pulse having the same frequency. In the signal path(s) up to the switch 80, the log video detectors 83 to 88 will not only have detected the presence of a signal but they would have analysed it for pulse width and pulse repetition interval (pri).

As far as the measurement of the frequency of the detected signal presence is concerned then the output of the switch 80 is either simply filtered in the bandpass filter 102 and has its frequency measured by the IFM module 100, or is further analysed by the components in the box 106 as will now be described. After amplification in the amplifier 108, the signal is filtered and passed by one of the filters 112, 114, 116. The signal then undergoes frequency translation in one of the mixers 118, 120 and 122 and the frequency of the output signal from that mixer is measured by the IFM module 104, the switch 136 having been operated in response to the detection of the signal presence by the appropriate log video detector 130, 132, 134.

In the case of detecting a single 100 nS radar pulse, the probability of obtaining frequency information on a single pulse signal will be reduced to about 16% (although the possibility of detecting a signal presence is 50%). Whilst in theory the multiplexing rate of the switches 96, 98 and 136 could be increased to increase the probability of detection of a single pulse, a limit is imposed by the IFM modules currently available because they generally need a pulse of 70 to 100 nS in order to be able to carry out a frequency measurement. Obviously if the received pulses are of longer duration then the probability of detecting a presence increases.

Although the described and illustrated embodiments have two

channels 68, 70, one could have more than two channels if the cost and complexity is justified. This may be the case if it is desired to detect the presence of two simultaneous signals having different frequencies. For example this could be done in Figure 5B by adding a third channel with local oscillators having the frequencies 104 GHz and 112 GHz. Then if two simultaneous radar pulses arrive at say 64 GHz and 96 GHz, the receiver will register a presence in all three channels and the signal processing module can identify the received signal as a multiple frequency pulse signal. Other techniques can then be adopted to identify the individual frequencies. Without the third channel, the receiver would have falsely registered the simultaneous 64 and 96 GHz signals as an 80 GHz signal. Another reason to add channels is to increase both the instantaneous and overall frequency coverage without reducing the probability of intercept.

At high input power levels, harmonic generation by the mixers and IF amplifier chain can present a problem. The IFM module will measure the largest signal present and if the input power level is limited then this should always be the fundamental. A margin of 10 dB fundamental to harmonic ratio is recommended to avoid frequency ambiguities.

In implementing the receiver in accordance with the present invention, the mixer operating in the 18 to 40 GHz range can be fabricated using ridge waveguide techniques. However, in the case of the receiver shown in Figure 5B which almost covers an octave bandwidth at frequencies between 60 to 108 GHz, the mixers can be constructed in standard rectangular waveguide or finline without recourse to ridge transitions or matching sections.

If desired each channel can have its own antenna thereby avoiding the need for hybrid tee power splitter between the common antenna and the input to each channel.

CLAIMS:

1. An electronic surveillance system in which a received signal is applied to at least two parallel channels, the channels including frequency translating means each of which includes means for producing different local oscillator (LO) signals which are so related that the upper sideband of the lower LO frequency produced in one channel overlaps the lower sideband of the upper LO frequency produced in the other channel, amplifying means in each channel for amplifying the output of the frequency translating means, means associated with each channel for detecting presence of a sideband signal in either or both channels, and means responsive to the detection of a signal for connecting an instantaneous frequency measuring device to the selected channel.

2. A system as claimed in Claim 1, wherein first and second LO signal producing means are associated with each of the signal translating means, and switching means are provided for simultaneously switching between the first and second LO signal producing means, the frequencies of the LO signal producing means being such that the sidebands which may be produced when the first LO signal producing means are selected interleave contiguously with the sidebands which may be produced when the second LO signal producing means are selected to cover the bandwidth of the frequency range being surveyed.

3. A system as claimed in Claim 2, further comprising means for frequency analysing a signal in the selected channel, the frequency analysing means comprising a plurality of further channels, each having a bandpass filter, the pass bands of the filters being contiguous over the frequency range of the sideband of interest, further frequency translation means connected to the output of the bandpass filter and a detector for detecting the presence of a signal in its associated further channel, and switching means

controllable in response to the detection of a presence in one of the further channels for connecting said one further channel to the instantaneous frequency measuring device.

4. A system as claimed in Claim 1, 2 or 3, wherein the static gains of the channels are matched.

5. A system as claimed in any one of Claims 1 to 4, further comprising signal isolating means for isolating the mixers in each channel.

6. A system as claimed in any one of Claims 1 to 5, further comprising signal limiting means for limiting the power level of the fundamental in the signal present.

7. An electronic surveillance system constructed and arranged to operate substantially as hereinbefore described with reference to Figures 3A to 5B of the accompanying drawings.

Amendments to the claims have been filed as follows

CLAIMS:

1. An electronic surveillance system in which a received signal is applied to at least two parallel channels, each of the channels including frequency translating means which include a local oscillator (LO) signal producing means, the local oscillator signals produced by each said producing means being such that different predetermined LO signals are applied contemporaneously to the frequency translating means in each channel, the contemporaneously applied LO signals being so related that the upper sideband of the lower LO frequency produced in one channel overlaps the lower sideband of the upper LO frequency produced in the other channel, amplifying means in each channel for amplifying the output of the frequency translating means, means associated with each channel for detecting presence of a sideband signal in either or both channels, and means responsive to the detection of a signal for connecting an instantaneous frequency measuring device to the selected channel.

2. A system as claimed in Claim 1, wherein first and second LO signal producing means are associated with each of the signal translating means, and switching means are provided for simultaneously switching between the first and second LO signal producing means, the frequencies of the LO signal producing means being such that the sidebands which may be produced when the first LO signal producing means are selected interleave contiguously with the sidebands which may be produced when the second LO signal producing means are selected to cover the bandwidth of the frequency range being surveyed.

3. A system as claimed in Claim 2, further comprising means for frequency analysing a signal in the selected channel, the frequency analysing means comprising a plurality of further channels, each having a bandpass filter, the pass bands of the filters being contiguous over the frequency range of the sideband of interest, further frequency translation means connected to the output of the bandpass filter and a detector for detecting the presence of a signal in its associated further channel, and switching means

controllable in response to the detection of a presence in one of the further channels for connecting said one further channel to the instantaneous frequency measuring device.

4. A system as claimed in Claim 1, 2 or 3, wherein the static gains of the channels are matched.

5. A system as claimed in any one of Claims 1 to 4, further comprising signal isolating means for isolating the mixers in each channel.

6. A system as claimed in any one of Claims 1 to 5, further comprising signal limiting means for limiting the power level of the fundamental in the signal present.

7. An electronic surveillance system constructed and arranged to operate substantially as hereinbefore described with reference to Figures 3A to 5B of the accompanying drawings.
